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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 63

GUNFIRE TEST OF GOODYEAR SELF SEALING FUEL CELLS WITH 20mm PRACTICE AND .60 CALIBER BALL AMMUNITION

FINAL Report

Task Assignment TED No. NPG AE53804

Copy No. _____

Classification [redacted]

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NPG REPORT NO. 63 [redacted]

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Gunfire Test of Goodyear Self Sealing Fuel Cells
With 20mm Practice and .60 Caliber Ball Ammunition

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PART A

SYNOPSIS

1. This is a final report on the gunfire tests of the Goodyear self sealing fuel cells conducted under TED No. NPG AE538041.

2. The object of this test was to determine the self sealing qualities of the fuel cells when subjected to 20mm and .60 caliber gunfire. The test was conducted in accordance with the requirements set forth in the Army-Navy Aero Specification AN-T-49a-1.

3. Two 20mm Practice and two .60 caliber ball projectiles were fired into cell number 86. A total of eight wounds was produced, five of which sealed satisfactorily. Round number four, a .60 caliber ball projectile, produced extensive damage to the area around the exit wound and the testing on this cell was discontinued.

4. Three 20mm practice and four .60 caliber ball projectiles were fired into cell number 71. A total of fourteen wounds were produced, eight of which sealed satisfactorily according to the requirements of reference (b). Five of the wounds which failed to seal satisfactorily did seal to damp in four minutes. Round number six, a tumbled .60 caliber ball projectile, punched out the sealant in the entrance wound.

5. It is concluded that the self sealing performance of the fuel cells was unsatisfactory according to the requirements of reference (b).

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Gunfire Test of Goodyear Self Sealing Fuel Cells
With 20mm Practice and .60 Caliber Ball Ammunition

PART B

INTRODUCTION

1. AUTHORITY:

This test was conducted under TED No. NPG AE538041, established by reference (a) which directed the gunfire test of the Goodyear non-metallic self sealing fuel cells.

2. REFERENCES:

a. BuAer ltr Aer-AE-53 dated 17 May 1948.
b. Army-Navy Aeronautical Specification AN-T-49a-1.
c. Copy of Goodyear Tire & Rubber Co. ltr dated 16 April 1948.

3. BACKGROUND:

The Goodyear Tire & Rubber Company has submitted to the Naval Proving Ground two 1' x 2' x 3' non-metallic self sealing fuel cells. This report deals with the gunfire testing of the subject fuel cells.

4. OBJECT OF TEST:

As requested by reference (a), this test was conducted to determine the self sealing qualities of the fuel cells when subjected to 20mm and .60 caliber gunfire. Paragraph F-5c of reference (b) was used as a guide in conducting this test.

5. PERIOD OF TEST:

a.	Date of Project Letter	17 May 1948
b.	Date Necessary Material Received	19 April 1948
c.	Date Test Started	11 June 1948
d.	Date Test Completed	11 June 1948

6. REPRESENTATIVES PRESENT:

Mr. John Checkovich	Bureau of Aeronautics
Mr. James Merrill	Goodyear Tire & Rubber Co.
Mr. Clyde Wheeler	Goodyear Tire & Rubber Co.

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

The dimensions of the two Goodyear non-metallic self sealing fuel cells are 1' x 2' x 3'. The construction of the cells is as follows:

Cell No. 71		Thickness (Inches)	Weight (lbs/sq.ft.)
1st Ply	Inner Ply GRN	.030	.170
2nd "	Sealant (Natural Rubber)	.040	.200
3rd "	Nylon cord fabric coated on both sides with natural rubber sealant	.032	.130
4th "	Sealant (Natural Rubber)	.040	.200
5th "	Nylon cord fabric coated on both sides with natural rubber sealant	.032	.130
6th "	Sealant (Natural Rubber)	.040	.200
7th "	Nylon cord fabric coated on both sides with natural rubber sealant	.032	.130
8th "	Sealant (Natural Rubber)	.040	.200
9th to 15th Ply (Incl.)	Nylon cord fabric coated both sides Plioform resin	.032	.158 ea.
16th Ply	Nylon cord fabric coated one side Plioform resin and outside with GRN	.032	.154
	Estimated cement		.100
		.542	2.72

The actual weight of Cell number 71 is 66 pounds.

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Cell No. 86

Cell number 86 is constructed the same as Cell number 71 except the total plies of non-metallic material is six instead of eight. The estimated total gage is .478 inches and the estimated total weight, 2.37 pounds per square foot. The actual weight of the cell is 59 pounds.

8. DESCRIPTION OF TEST EQUIPMENT:

The following equipment was used in conducting this test:

a. 20mm aircraft machine gun, M-3.
b. .60 caliber aircraft machine gun, T17E3.
c. 20mm practice ammunition, T-24.
d. .60 caliber ball ammunition, T-77.
e. Non-metallic tumble board.
f. 40% aromatic blend of aviation gasoline.

9. PROCEDURE:

This test was conducted in accordance with the requirements of paragraph F-5c of reference (b) with the exception that 20mm practice and .60 caliber ball ammunition was used in lieu of the specified .50 caliber.

10. RESULTS AND DISCUSSION:

a. Two 20mm practice and two .60 caliber ball projectiles were fired into cell number 86. A total of eight wounds was produced, five of which sealed satisfactorily. Round number four, a .60 caliber ball projectile, produced extensive damage to the area around the exit wound, necessitating the discontinuance of the test on this cell. Figures 1 and 2 show the damage to this cell.

b. Three 20mm practice and four .60 caliber ball projectiles were fired into cell number 71. A total of fourteen wounds was produced, eight of which sealed satisfactorily; however, five of the wounds which failed to seal in accordance with reference (b), did seal to damp in four minutes. Round number six, a tumbled .60 caliber ball projectile, punched out the sealant in the entrance wound. Figures 3 and 4 show the damage to this cell.

c. The tabulated results of the gunfire test are contained in Appendix (B).

Gunfire Test of Goodyear Self Sealing Fuel Cells
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PART D

CONCLUSIONS

11. It is concluded that the self sealing performance of the two fuel cells was unsatisfactory according to the requirements of paragraph F-5c of reference (b).

PART E

DISPOSITION OF MATERIAL

12. Instructions from the Bureau of Aeronautics as to the disposition of the fuel cells is requested.

SUBMITTED:

B. K. LLOYD
LCDR, USN
Aviation Ordnance
Special Projects Officer

CONCUR:

M. P. BAGDANOVICH
Captain, USN
Aviation Ordnance
Officer

APPROVED: C. T. JOY
Rear Admiral, USN
Commanding Officer

CONCUR:

W. C. BRYSON
Captain, USN
Experimental Officer

W. H. BENSON
Captain, USN
Ordnance Officer
By direction.

NPG REPORT NO. 63 UNCLASSIFIED [redacted]

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Classification cancelled or changed to Unclassified
AUTH: NWL 1st Ltr dtd 13 Jan 60
By Chester Beeks
Signature and Grade
Date 15 Jan 60

Final Report

on

Task Assignment TED No. NPG AE538041

Gunfire Test of Goodyear Self Sealing Fuel Cells With 20mm Practice and .60 Caliber Ball Ammunition

Project No: TED No. NPG AE538041
No. of Pages: 6

Date:
28 JUL 1948

UNCLASSIFIED [redacted]

KP9 36576 - Gunfire Test of Goodyear Non-Metallic Self Sealing Fuel Cells. A view showing the entrance [illegible] panel of Cell No. 86. The cell was filled [illegible] aromatic blend of aviation [illegible] grade caliber ammunition.
RESTRICTED

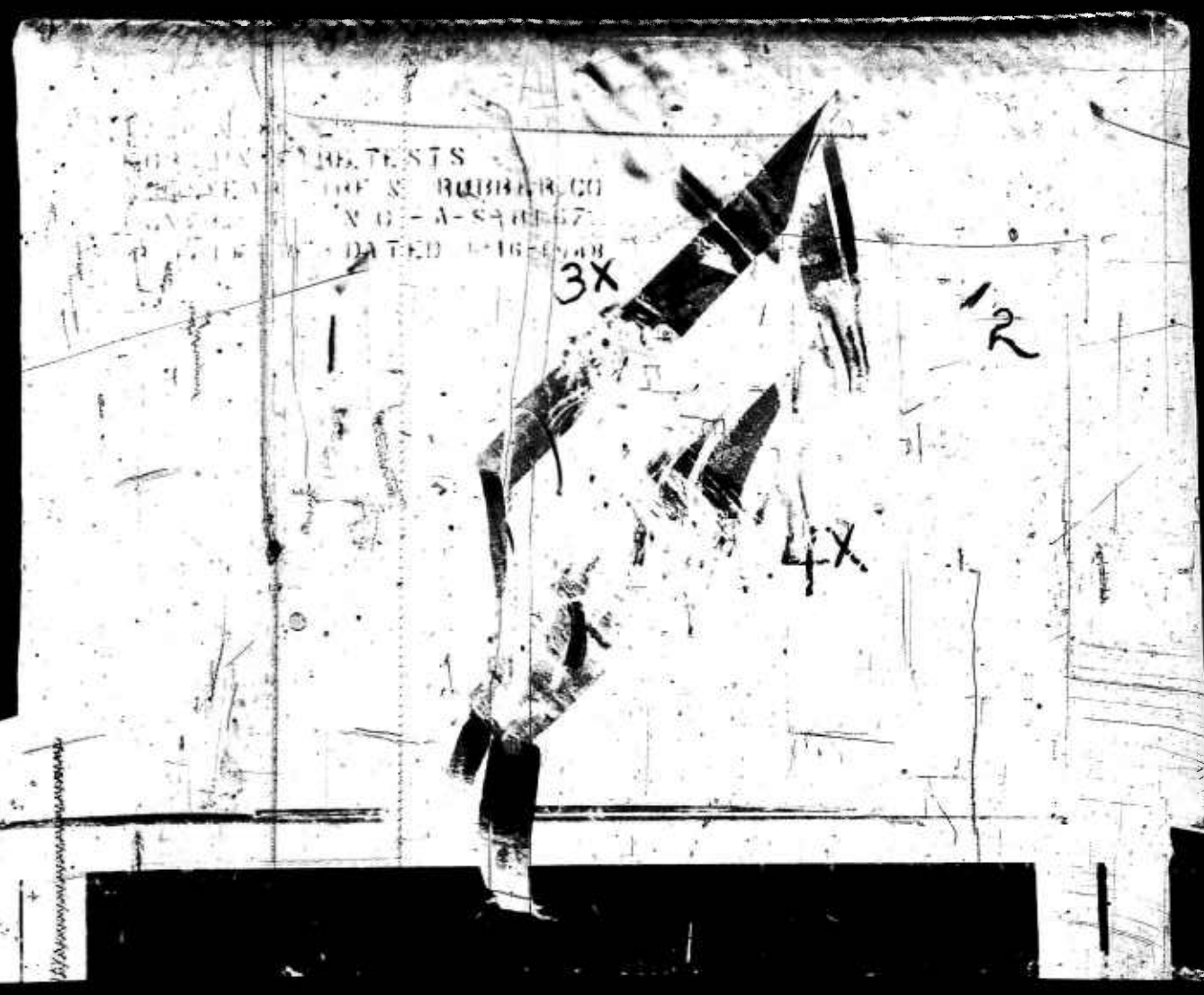
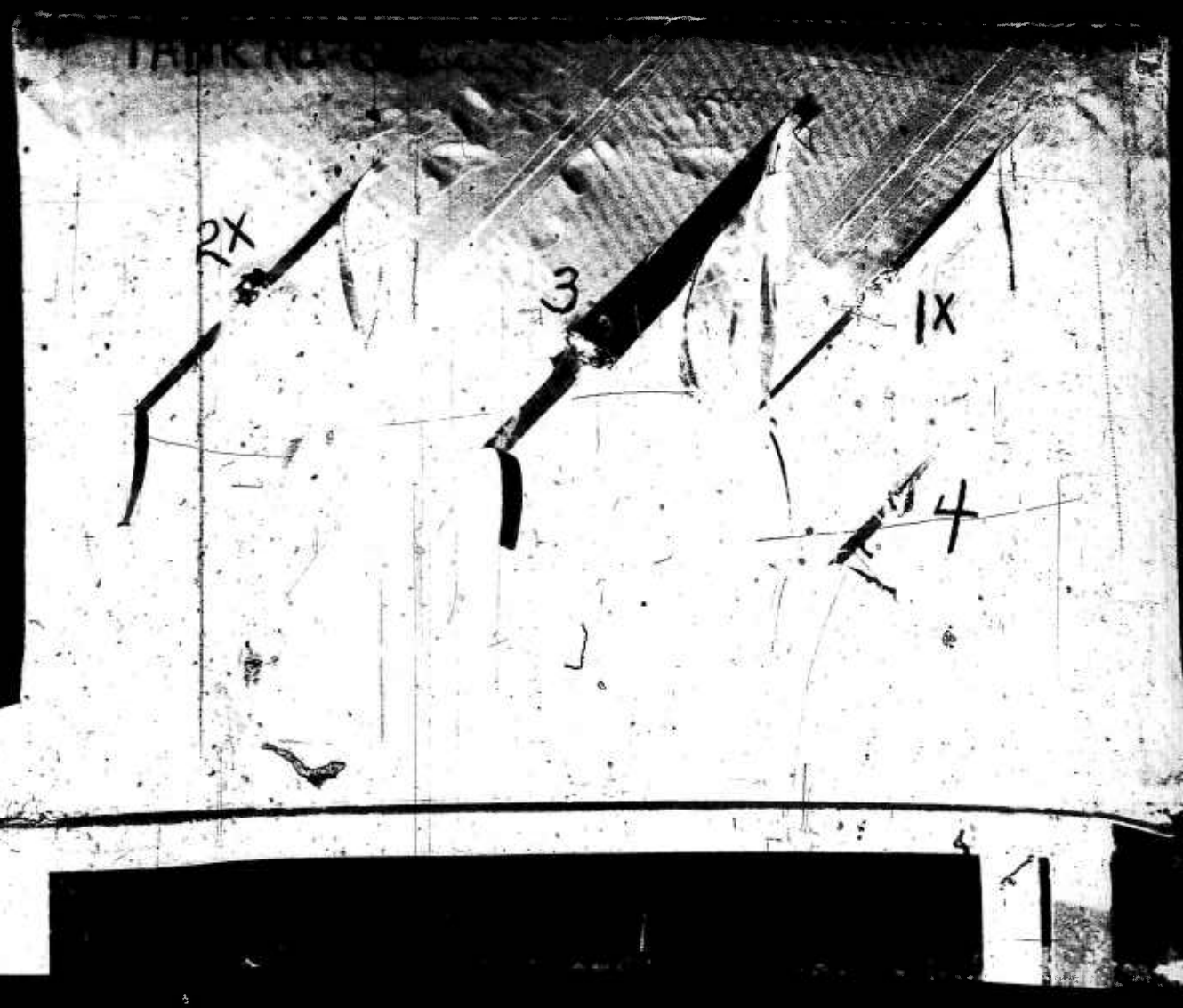


FIGURE 1

NP9 36577 - Gunfire Test of Goodyear Non-Metallic Self Sealing Fuel Cells. A view showing the entrance and exit wounds in a side panel of Cell No. 86. The cell was filled to within 2" of the top with a 40% aromatic blend of aviation gasoline and gunfire tested with 20mm and .60 caliber ammunition.
RESTRICTED

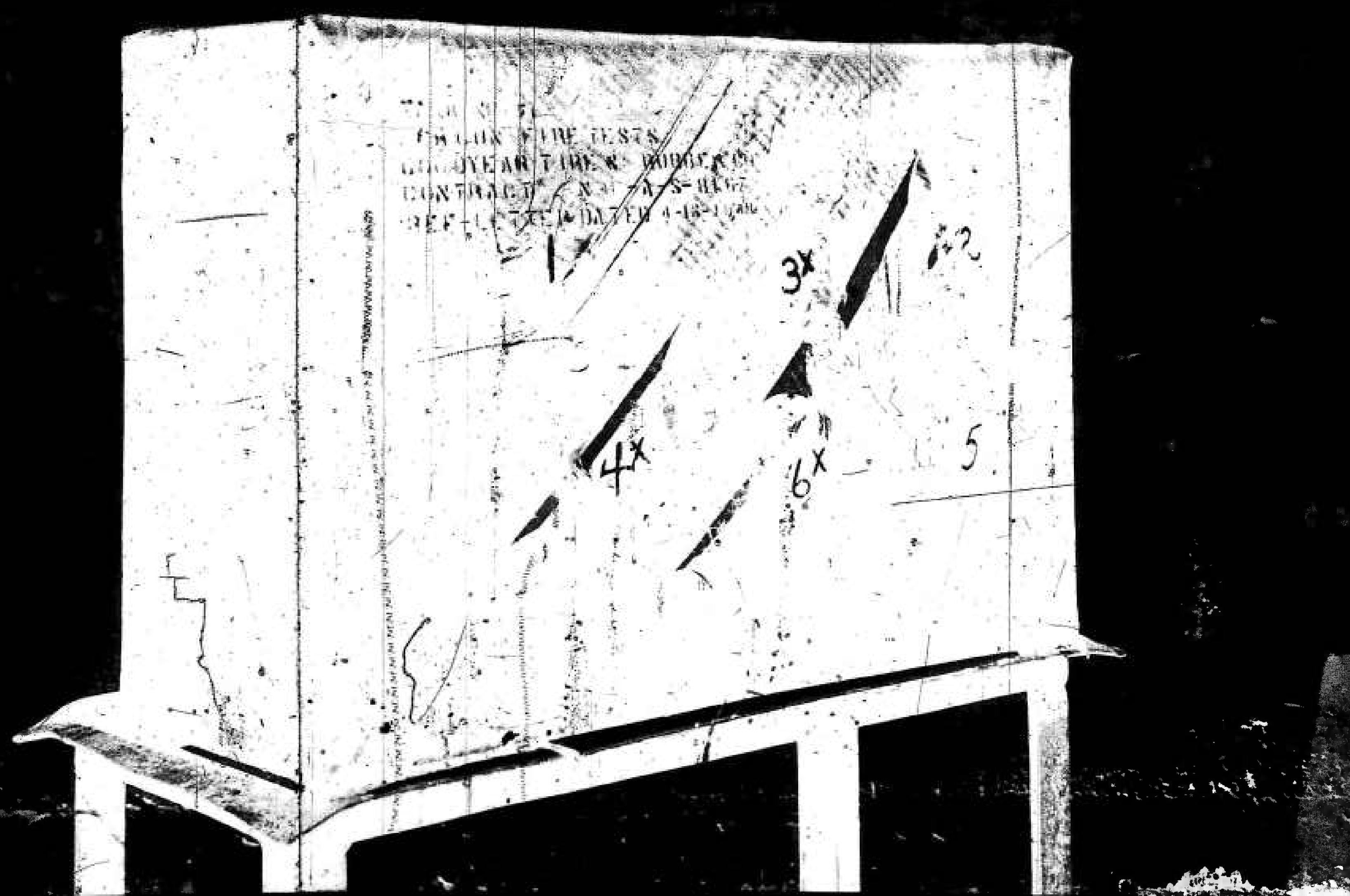
11 June 1940



NPG 36578 - Gunfire test of Goodyear Non-Metallic Self Sealing Fuel Cells showing the entrance and exit wounds in a side and end panel of Cell No. 71. The cell was filled to within [illegible] of the top with a 40% aromatic blend of aviation gasoline and gunfire tested with 20mm and .60 caliber ammunition.

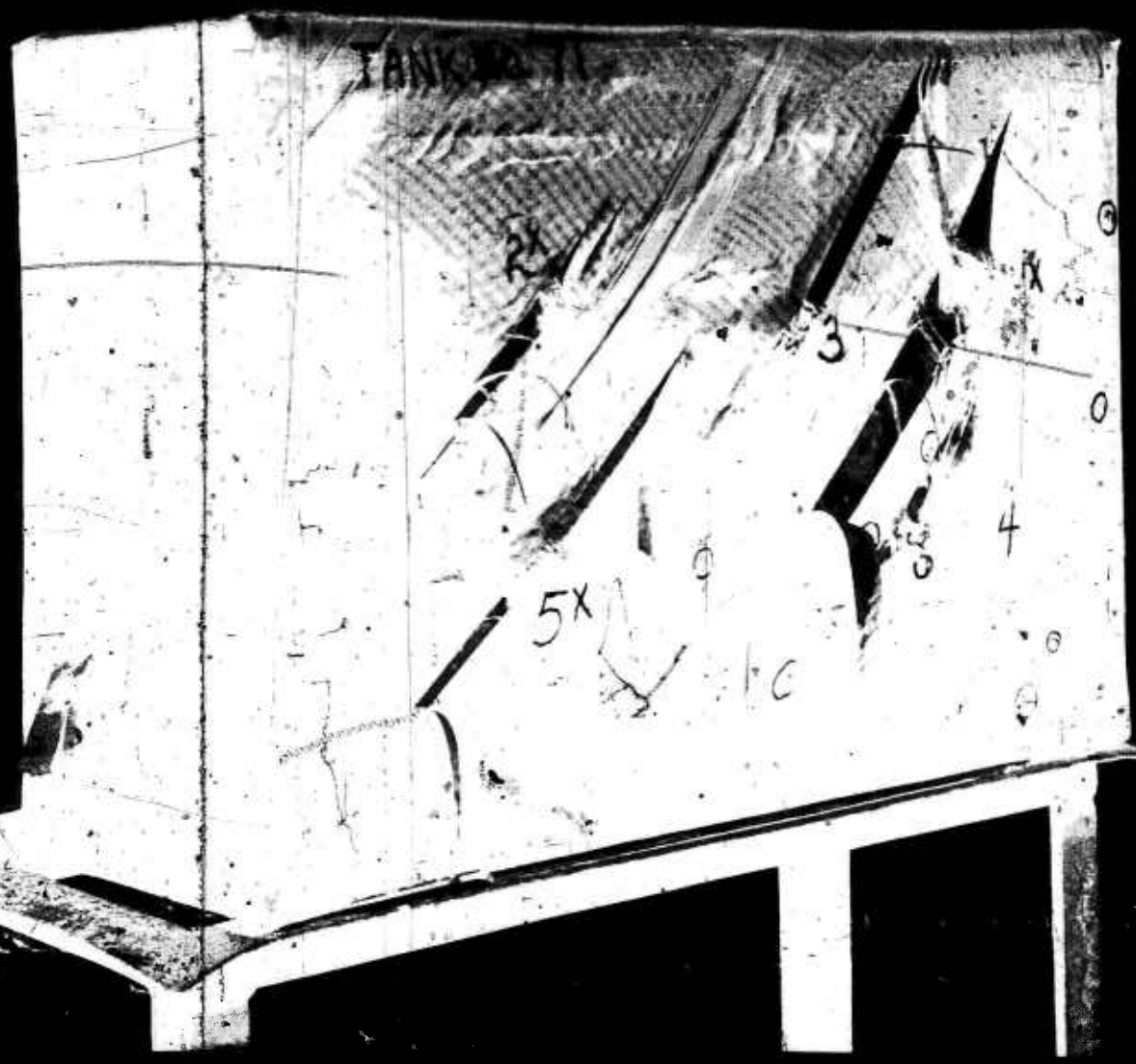
RESTRICTED

11 June 1948



NP9 36579 - Gunfire Test of Goodyear Non-Metallic Self Sealing Fuel Cells. A view showing the entrance and exit wounds in a side and end panel of Cell No. 71. The cell was filled to within 2" of the top with a 40% aromatic blend of aviation gasoline and gunfire tested with 20mm and .60 caliber ammunition. The encircled wounds were produced by the fragments of the projectile's jacket.
RESTRICTED

11 June 1948



NPG REPORT NO. 63 [redacted]

Gunfire Test of Goodyear Self Sealing Fuel Cells
With 20mm Practice and .60 Caliber Ball Ammunition

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TABULATED RESULTS OF GUNFIRE TEST

Preliminary Notes:

1. In the first column of the following table, the numbers with "x" after them refer to the exit wound made by the subject round.

2. Angle of impact as used in the following table is the angle between the line of fire and the surface on which impact occurs.

3. The following abbreviations are used:

SRH	Small round hole.
LH	Leaking heavily.
LM	Leaking moderately.
LS	Leaking slightly.
SM	Seeping moderately.
SS	Seeping slightly.

[redacted] APPENDIX B

TABULATED RESULTS OF GUNFIRE TEST

Round No.	Cell No.	Ammunition	Angle of Impact (degrees)	Approx. Head of Fuel (inches)	Size of Wound (inches)	Leakage After Impact	Sealed to	Time (min)	Remarks
1	86	20mm Pract.	90	6	SRH	Dry			None.
1x				7	1/2	Dry			Shredding of outer ply.
2	"	.60 Cal. Ball.	"	8	SRH	SM	Dry	2	Projectile was tumbled.
2x				8	1/2	LH	LM	4	None.
3	"	20mm Pract.	"	9	1	Dry			Projectile was tumbled.
3x				10	2	LM	SH	4	None.
4	"	.60 Cal. Ball.	35	12	SRH	Dry			None.
4x				13	3	LH	LH	4	Heavy damage to area around the wound. Test was discontinued.
1	71	20mm Pract.	90	6	SRH	Dry			None.
1x				7	1 1/2	Dry			None.
2	"	20mm Pract.	"	7	SRH	Dry			None.
2x				7	SRH	Dry			None.

Gunfire Test of Goodyear Self Sealing Fuel Cells With 20mm Practice and .60 Caliber Ball Ammunition

TABULATED RESULTS OF GUNFIRE TEST

Round No.	Cell No.	Ammunition	Angle of Impact (degrees)	Approx. Head of Fuel (inches)	Size of Wound (inches)	Leakage After Impact	Sealed to	Time (min)	Remarks
3	71	20mm Pract.	90	10	1 1/4	SS	Dry	1	Projectile was tumbled.
3x				10	1 1/2	LM	SM Damp	2 5	None.
4	"	.60 Cal. Ball	"	13	SRH	LS	SH Damp	1 4	None.
4x				13	SRH	Dry			None.
5	"	.60 Cal. Ball.	90	14	SRH	SS	Damp	1	None.
5x				15	1	LS	Damp	4	None.
6	"	.60 Cal. Ball	"	14	1	LH	LH	4	Projectile was tumbled. Sealant punched out.
6x				14	1 1/4	SS	Damp	2	None.
7	"	.60 Cal. Ball	0	8	SRH	LS	SS Damp	2 4	None.
7x				10	1 3/4	SH	SS Damp	2 4	None.